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Nuptial Flight of *Prenolepis imparis* (Say) (Hymenoptera: Formicidae)

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Abstract Observations were made on a nuptial flight of the ant *Prenolepis imparis* (Say) on March 5 at Blacksburg, Virginia. Average temperature during the flight period was an estimated 70° F. Observations were made on the mating activities of 55 females. Detailed observations were made on the wing-shedding process in one female. Observations on this flight were compared with those made earlier in Missouri by Talbot.

Prenolepis imparis (Say) is, according to Dr. M. R. Smith (in litt.), "a common and widely distributed native North American ant. The ants nest in the soil and the workers feed mainly on honeydew. Often the abdomen of these ants is so distended that the workers walk with difficulty. The species is a very interesting one in that the ants can stand more cold than any other North American ant known to me. They are the first to take their nuptial flights in the spring." Van Pelt (1963), in a table showing the altitudinal distribution of ants in the Southern Blue Ridge Province, lists this species as "occasional" at elevations from 3,500-5,000 feet. According to him, this ant frequently nests under rocks at these elevations. Wesson and Wesson (1940) state, however, that nests of this species were not detected beneath stones and logs in south-central Ohio.

In studying the habits of this species throughout the year, Talbot (1943a, 1943b) found that in contrast with most ants, this species did not maintain a strict hibernation, the workers occurring aboveground during the winter whenever the temperature was above freezing, with active foraging beginning about 35° or 40° F. and reaching a peak of activity between 46° and 65° F. She observed (Talbot, 1943b) a decrease in numbers aboveground at temperatures above 60° F. This decrease in numbers aboveground progressed steadily with rising temperatures until, above 75° F., almost no ants were found aboveground. She also discovered that a correlation of increased activity with higher

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relative humidity (peaks at 80–100%) occurred in the range of temperatures at which activity is at its height (46–65° F.).

Contrary to the habits of many ants, *Prenolepis imparis* maintains males and females in the nest throughout the winter (Talbot, 1943a). During the winter, a mature colony consists of the nest queen, males and females, and two types of workers, small dark nonrepletes and light colored, enormously swollen repletes. The function of the repletes is to store food for the remainder of the colony. Following the early spring nuptial flights, practically all aboveground activity ceases until midsummer (Talbot, 1943a).

That *Prenolepis imparis* nuptial flights occur in early spring at a time when other species are just completing hibernation is documented by Talbot (1943a, 1945), who observed flights on April 6, 9, and 10 in 1941 and March 25, 29, and 30 in 1943 at St. Charles, Missouri. According to her, days between flights were cold. She suggests that "one may venture the generalization that flights occur during the warmest parts of the first days of spring when the temperature reaches 70° F. or above."

For further details on the biology and taxonomy of this species see Wheeler (1908, 1930), Talbot (1943a, 1943b, 1945), and Dennis (1941).

OBSERVATIONS ON NUPTIAL FLIGHT

The following observations on a nuptial flight of *Prenolepis imparis* were made March 5, 1961, at Blacksburg, Virginia (elevation 2,000 feet) in the lawn and flower garden behind my residence on the V.P.I. campus. The lawn was approximately 50 × 50 feet and most observations were made in its center. Specimens were determined by Dr. M. R. Smith, Agr. Res. Ser., U. S. Dept. Agriculture. Observations were made from the time the flight was detected at 12:30 p.m. until they virtually ceased activity at 4:30 p.m. Temperature averaged an estimated 70° F. during the observation period. The preceding 2 weeks were unusually warm. A slight overcast existed during most of the observation period but the sun was frequently visible. Clouds began forming at 3:30 p.m., and after 3:45 p.m. the sun was no longer visible. There were intermittent gusts of wind up to an estimated 15 m.p.h. or more throughout the observation period. The air was completely calm, however, in between these gusts of wind.

The maximum and minimum temperatures reported for March 5, 1961, at Blacksburg were 74° and 48° F., respectively. This was the third day in 1961 (Anonymous, 1961) that the temperature exceeded 65° F. [the other two dates being February 25 (68° F.) and 28 (66° F.)] at this location. The average daily maximum temperatures for the preceding 2 weeks (February 19–March 4) was 56.8° F. and the average daily minimum 33.8° F. The daily maximum temperatures for the preceding 5 days (February 28–March 4) were 66, 52, 52, 52, and 64, respectively, and the average minimum daily tempera-

tures 36, 29, 32, 27, and 34, respectively. These data tend to confirm the generalization of Talbot (1945) quoted above.

At 12:30 p.m. a yellow bedspread that had just been washed was hung on a clothesline approximately in the center of the lawn. Within seconds, several winged male ants appeared on the spread. Shortly afterwards, two winged females were detected. At this time, a search for their nest was made. It was discovered beneath a board (8 inches \times 4 feet) adjacent to some rocks about 15 feet from the spread. Several workers and winged females were present beneath the board when the nest was located. No males were observed around or beneath the board. Within minutes, males became very common on the spread, in the air (up to 8 feet) around it, and were observed flying around the grass 1-4 inches aboveground. The males had apparently left the nest before the females. No other nests were encountered in the area, but it is probable (due to the number involved) that other colonies of this species were involved. Shortly afterwards, the number of females attracted to the spread increased, though seldom were there more than five or six present on the spread at a given time.

It is estimated that 100 females and 2,500 males were involved in the observed nuptial flight. This is probably an underestimate, especially for the females, since systematic observations of those on the ground and in the grass were not made. No ants were observed around the periphery of the yard. Males alone were observed swarming in shrubbery near the nest. All females observed were in the vicinity of the nest and spread.

Close observations were made on the mating acts of 55 females on the spread and ground. No matings were detected in the air or in the vicinity of the board. In only eight of the observed matings was more than one male involved in precopulatory activities, though commonly after union had been effected, other males attempted to mount the female but quickly gave up and left. Males apparently were not attracted to females from a distance. Usually when the male was within 1 inch of the female he headed directly toward the tip of her abdomen. It was unusual to see a male and a female encounter one another face to face and then effect a union. In no case, either between male and female or between competing males, was any actual combat observed. With competing males (more than one attempting to mount a female simultaneously), there was simply a mad rush to mount the female. After successful union of a pair was accomplished, excess males left immediately. Following successful union, pairs remained united for an average of over 5 minutes.

Winged males of this species are much smaller and more active than the larger females. In mating, the male grasps the female's abdomen and retains either a normal upright position on the dorsal surface of the female's abdomen or extends itself in the opposite direction from the female with the ventral surface facing upwards.

Several in copula pairs were collected in empty vials and placed in a cold storage freezer for later preservation. All pairs which were united when placed in the freezer remained united. When not placed in the freezer immediately after capture, couples became disengaged within the normal time.

The level of activity of males and females was considerably different. Males were very active on and around the spread and at grass level throughout the observation period. Females were relatively inactive at all times. On the spread, their only action, in general, was to climb toward the top of the bedspread. If not encountered by males prior to reaching the top of the spread, they simply remained inactive on the top until encountered by males. Several individuals were blown from the spread by the wind or action of the wind in "whipping" the spread. This probably accounts for most of the winged females found on the ground beneath the spread. Only one in copula pair was observed to fly united from the spread. It was followed for about 10 feet but it disappeared in the shrubbery.

Winged females transferred from beneath the board to the spread were immediately encountered by males and in each case a successful union was accomplished. Several females were observed flying away from the spread and nest area but no matings were observed in the air. Only two unions were observed to take place on the ground and these were possibly second matings for the females. Three copulating pairs were separated when dislodged from the spread by wind action after having remained united for 5 or more minutes. In each case, the female was immediately returned to the spread by the observer. Each female later mated with another male. Thus, the females of this species can mate more than once. Unfortunately, no attempt was made to determine the maximum number of matings that could be effected by a given female. Several solitary winged females were detected in the grass beneath the spread. When placed on the spread, mating was accomplished in every instance.

Several wingless females were collected from beneath the spread. The reason for their dealated condition was unknown at the time but was explained by later observations on a single female. When wingless females were placed on the spread they attracted no attention from the males. In each instance, the wingless female immediately dropped to the ground.

By 3:45 p.m. rain was threatening and the sun had not been visible since 3:30. At 4:30 p.m. only about a dozen males were observed in flight over the entire lawn. None were on or in the vicinity of the spread. One winged female and three workers were observed around the nest entrance beneath the board. The winged female appeared to be attempting to shed its wings. Throughout the observation period, no workers were observed away from the immediate vicinity of the nest and no winged forms of either sex were observed to return to the nest.

No additional flights were observed at this location in subsequent days

nor were workers detected aboveground in the period March 5 to June 30. No observations were made after the latter date.

OBSERVATIONS ON A SINGLE FEMALE (FROM FIELD NOTES)

At 2:30 p.m. a single female was observed on the spread. She was immediately mounted by a male. At 2:35 p.m. the pair fell to the ground and became disengaged. The female began climbing around on grass blades. At 2:40 p.m. two males were attracted to the female. One male was successful in uniting with the female. The female began increasing her speed in climbing up and down grass blades. She continued walking up and down grass blades, dragging the male behind her, for about 30 minutes. The male repeatedly attempted to grasp grass blades, in an apparent attempt to free himself, but in vain. During this time the female covered a distance of 4 feet. Three males were attracted to the couple but each gave up in attempts to mate and disappeared. The female repeatedly attempted to fly but was never successful.

At 3:15 p.m., the male finally attained a sufficient grasp on a blade of grass to free himself. He immediately disappeared in the grass. The female continued traveling up and down grass blades, periodically stopping to bite the tip of her abdomen and preen her antennae. In addition, she periodically flexed her wings as if attempting to fly. Sustained flight was never accomplished, the greatest distance covered being approximately 6 inches.

By 3:30 p.m., her walking activity had decreased but wing flexing had increased. By this time she had arrived in a very dense patch of grass blades and began going around and under blades of grass in one spot, turning somersaults while doing so and flexing her wings continuously. She finally succeeded, after repeated contortions and wing flexing, in breaking her wings off one at a time. By 3:35 p.m. the female had shed all her wings. She remained perfectly still for about 2 minutes then resumed walking. After about 3 minutes, she stopped again, rested about 3 minutes, then descended to the ground and disappeared in the litter. She traveled approximately 20 feet from the spread during the 65 minutes she was under observation.

Because of the chance encounter with the nuptial flight described above, no observations were made on preflight activities. According to Talbot (1945), these consist of "multiplying nest entrances beyond the usual one, and of exploratory above ground excursions made by the males. Usually these activities take place over a period of several days. . . ."

The observations reported here are in agreement with those made of several flights of this species by Talbot (1943a, 1943b, 1945) in Missouri. The dates and times of day were comparable, as well as the general behavior of both sexes in respect to height of flight and relative time of emergence. In both instances, multiple matings were observed. However, the duration of mating was given by her as being 2 minutes or less, whereas my observations indicated 5 or more

minutes as the average mating time. Since temperatures at both locations during flights were very similar, this difference in time required to complete the mating act was not due to rates of activity varying with temperature. She observed one wingless female mating whereas I was unable to effect mating in wingless females. In addition, she observed that "workers took part in the flight by coming out in great numbers and moving about among the winged forms" (Talbot, 1945). In the Blacksburg flight, only a few workers were detected. All were in the immediate vicinity of the nest and took no active part in flight activities. She also noted (Talbot, 1945) that "At the close of each day's flight most of the remaining males and females went back into the nests unassisted, but a few males were carried back by workers." No ants were observed returning to the nest in the Blacksburg flight.

The number of specimens involved in the Blacksburg flight (estimated 2,500 males and 100 females) greatly exceeded the number reported by Talbot (1945): "Eleven colonies whose populations were counted (Talbot, 1943a) showed an average of 153.4 males and 19.6 females or 7.8 males per female."

SUMMARY

A nuptial flight of the ant *Prenolepis imparis* (Say) was observed on March 5, 1961, at Blacksburg, Virginia. The males and females were attracted to a bedspread on a clothesline, thus offering an excellent opportunity for observations on the mating habits and activities of this species. The flight occurred on the first day in 1961 that the temperature exceeded 68° F. It began shortly before 12:30 p.m. and ended at 4:30 p.m. The average temperature during the flight period was an estimated 70° F. Workers were not observed to participate in the nuptial flight, the only ones encountered being detected at the nest beneath a 8 inch × 4 foot board.

It is estimated that 100 females and 2,500 males were involved in this flight. The density of the females was probably underestimated since, in contrast with the males, they are weak fliers and, in addition, systematic observations of those on the ground and in the grass were not made. Observations were made on the mating activities of 55 females, primarily on the spread. It was noted that males were not attracted to females from a distance, but when within about 1 inch of the female they headed directly toward the tip of her abdomen. Frequently more than one male attempted to effect union with a given female at the same time. No active combat occurred, however, either between male and female or between competing males. After successful union of a pair was accomplished, excess males left immediately. In copula pairs remained united, on an average, for over 5 minutes. No aerial matings were observed.

Multiple matings were effected in several winged females by returning them to the spread after they had mated on the spread and fallen to the ground. No matings were observed or effected with dealated females. Detailed observations

on one female indicated that shedding the wings was an active process, occurring in this instance approximately 15 minutes after the last mating act ended. Repeated contortions, somersaulting, and wing flexing were exhibited by the female during wing shedding.

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Sex-Distinctive Chromatin and the Frequency of Males in the Moth Ear Mite

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Abstract Interphase cells containing single, comma-shaped chromatin masses were seen in aceto-orcein squashes of adult males, and in a small percent of the embryos, larvae, and protonymphs of the moth ear mite, *Dicrocheles phalaenodectes*. Such cells were not found in deutonymphs or in females. When passed through a succession of hosts, fertile females produced males at intervals throughout their period of oviposition; virgin females laid only inviable eggs. Out of a total of 594 mites representing the F₁ progeny of seven females, approximately 6.8% either developed into adult males or were judged from the presence of comma cells in their early stages to be potential males. On any individual host, the first eggs usually included one or more potential males, and since the deutonymphal stage may be omitted in male ontogeny, a male was normally among the first mature mites in any colony.

Young colonies of the moth ear mite *Dicrocheles phalaenodectes* (Treat, 1954, 1956, 1958) commonly include one or two males and many immature mites which eventually become females. Many of these females leave the host before engorgement, while some stay in the colony to become engorged and